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# Pediatric Health Aspects of PBBs

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**Many Michigan farm children are viewed as having suffered a deterioration in health coincident with contamination of diary cattle by PBBs. Among Wisconsin dairy farm children such a deterioration was a rare event. There is a suggestion that Michigan farm children who had multiple symptoms during the 1973–76 period are getting better. A discrete syndrome of ill health has not been identified among Michigan farm children. The symptoms complained of indicate a disruption of various physiological functions, including neurobehavioral, gastrointestinal and immunological. Children from quarantined farms do not have a higher prevalence of multiple symptoms than those from nonquarantined farms.**

## Population Studied

In November 1976, 343 children (age 0–16 years) of rural Michigan families were studied for the possible health effects of ingestion of polybrominated biphenyls (PBBs). These children were invited into the study in one of several ways. Ninety-five were from families selected from a random list of farms supplied by the Michigan Department of Agriculture: 50 of these children resided on quarantined farms and 45 resided on nonquarantined farms; 27 children were from families on the MDA Highest Contamination List; 36 children had parents who were members of the Farmers Advisory Council; 14 of these were from quarantined farms and 22 were from nonquarantined farms. One hundred and eighteen children were from families that entered the study by way of referral from doctors, lawyers or self; of these children, 67 were residents of quarantined farms and 51 were residents of nonquarantined farms. Thirty-five children were from nonfarm families that were known to have consumed meat or milk from quarantined farms and 31 were from families that had consumed meat or milk from nonquarantined farms. Of the whole Michigan study group, 158 children were resident on quarantined farms, 118 were resident on nonquarantined farms, and 66 were nonfarm children who consumed meat or milk purchased directly from a farm.

As a control group, 72 children of Wisconsin dairy farm families were studied in March, 1977. None of these children had any known exposure to PBBs.

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## Study Methods

For each child studied, the parents completed a medical history questionnaire (Fig. 1). These questionnaires were reviewed and annotated by one of two examining physicians. The children also received general physical examinations and blood and urine specimens were collected for laboratory

MEDICAL HISTORY AND SYMPTOM REVIEW

NAME _____ SEX _____ DATE OF BIRTH ____/____/____
Month -Day -Year

SCHOOL GRADE _____

Instructions: If your child has had any of the problems listed below, please mark with an "X" the year(s) when the problem occurred. If your child has not had the problem, please put an "X" in the "NO" column.

| | NO | pre-1973 | 1973 | 1974 | 1975 | 1976 |
|---|---|---|---|---|---|---|
| Headache | | | | | | |
| Dizziness | | | | | | |
| Difficulty sleeping | | | | | | |
| Irritability | | | | | | |
| Easily upset | | | | | | |
| Nervousness | | | | | | |
| Tiredness | | | | | | |
| Weakness | | | | | | |
| Loss of balance/clumsiness | | | | | | |
| Convulsions/fits/seizures | | | | | | |
| Tremors/shakes | | | | | | |
| Numbness | | | | | | |
| Loss of appetite | | | | | | |
| Eye redness | | | | | | |
| Eye discharge | | | | | | |
| Vision problem | | | | | | |
| Glasses | | | | | | |
| Multiple ear infections | | | | | | |
| Hearing problems | | | | | | |
| Frequent colds | | | | | | |
| Runny nose | | | | | | |
| Hay fever | | | | | | |
| Allergies | | | | | | |
| Sore throats | | | | | | |
| Tooth decay/cavities | | | | | | |
| Gum disease | | | | | | |

Examining physician: Please comment on frequency, duration and significance of positive answers in the space below.

FIGURE 1. Sample page of medical history questionnaire.

analyses. This presentation covers data from the medical history questionnaires.

On review of the questionnaires, it was immediately apparent that many of the Michigan parents thought their children had suffered a deterioration in health in the past 3 years. In order to study this group of children, the study population was divided into two groups: those who had multiple symptoms (MS) and those who were not symptomatic (MN). To do this, an arbitrary dividing line was used. Any child who had 10 or more symptoms in the years 1973-76 in excess of the number of symptoms for any prior year (1972-75) was placed in the symptomatic group; the remainder were classified as nonsymptomatic. According to this classification, 120 of the Michigan children and one Wisconsin child were symptomatic; 223 of the Michigan children and 71 of the Wisconsin children were nonsymptomatic.

## Results

The study groups were compared by sex and age distribution and no statistically significant differences were found.

The data were examined for temporal trends in the occurrence of symptoms (Fig. 2). The children were grouped in 4-yr age blocks and the mean

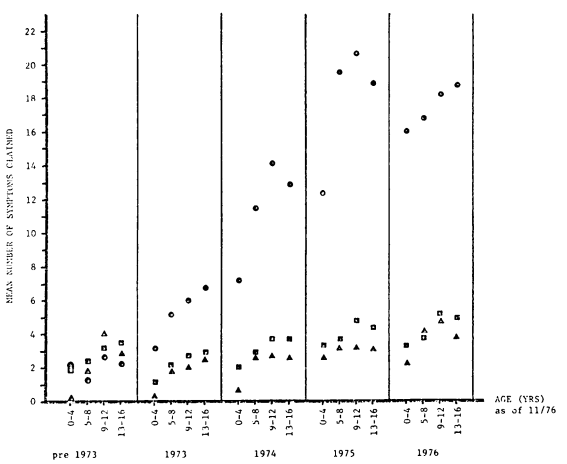


FIGURE 2. Mean number of symptoms claimed on medical history questionnaire by year and age group: (▲) Wisconsin children (W); (■) nonsymptomatic Michigan children (NM); (●) symptomatic Michigan children (MS).

number of symptoms for that age group was calculated for each year covered by the questionnaire. For the pre-PBB years (1972 and before), the MS, MN, and W groups had about the same number of symptoms. There was no statistically significant differences in the mean number of symptoms between the MN and W groups for any year covered by the study. Among the MS group, there was a slight rise in the mean number of symptoms in 1973. In the years 1974-76, the mean number of symptoms in the MS group was significantly higher than in either the MN or W groups. Careful inspection of Figure 2 suggests that the number of symptoms in the MS group declined somewhat from 1975 to 1976. This trend is in agreement with a subjective impression gained during the study that the children were in most cases viewed as recovering their health particularly during the second half of 1976.

The various groups of children were compared for the prevalence of symptoms (Table 1). In this analysis, if the symptom was claimed for any year (1973-76), the child was regarded as "positive" for that symptom. Such a classification does not take into account the severity of the symptom, its duration, or its relative significance compared to other symptoms.

The 120 (35%) Michigan symptomatic (MS) children accounted for 68.7% of the reported symptoms averaging 21.9 symptoms/child, whereas the MN children average 5.37 symptoms/child and the W children averaged 4.51 symptoms/child.

Comparison of all Michigan children with the Wisconsin children showed that there were statistically significant differences between the two for 35 of the 65 symptoms studied (Table 1). Except in the case of dental caries, the Michigan sample had a higher prevalence of each symptom.

By segregating the "symptomatic" children, the prevalence of symptoms among this group was striking. Comparison of the MS and MN groups showed that, except for five symptoms, the prevalence of each symptom was significantly higher in the MS group. The five exceptions were dental caries, "hay fever," acne vulgaris, fractures, and tachycardia.

When the MS group was compared to the W group all symptoms, except nine, were found to be significantly more prevalent in the MS group. The nine exceptions were dental caries, vision problems, otitis media, "hay fever," enuresis, bronchitis, pneumonitis, convulsions, and tachycardia.

To try to validate the "normality" of the MN group, it was compared to the W group for each of the symptoms. Statistically significant differences were found for only four symptoms: fatigue, anorexia and diarrhea were more prevalent in the MN group and dental caries were more prevalent in the W group.

The prevalence of multiple symptoms among Michigan children was studied by the type of farm residence and method of invitation into the study (Table 2). Those children from quarantined farms were less likely to have multiple symptoms (29%)

**Table 1. Prevalence (%) of symptoms claimed by Michigan (M) children who had multiple symptoms (MS) or no excess of symptoms (MN) and by Wisconsin children (W) for the period 1973-76.**

| Symptom | Prevalence of symptoms, % | | | | $\chi^2$ (2 × 2) | | | |
|---|---|---|---|---|---|---|---|---|
| | Nonsymptomatic (MN) (223) | Symptomatic MS) (120) | Total (M) (443) | Total (W) (72) | M vs. W | MS vs. MN | MS vs. W | MN vs. W |
| Frequent colds | 30.0 | 78.3 | 46.9 | 22.2 | 13.87[c] | 71.12[c] | 55.62[c] | 1.283 |
| Fatigue | 21.9 | 75.8 | 40.8 | 4.1 | 33.79[c] | 91.47[c] | 89.64[c] | 10.69[a] |
| Sore throats | 27.8 | 75.0 | 44.3 | 23.6 | 9.727[b] | 68.53[c] | 46.11[c] | 0.297 |
| Headaches | 24.2 | 73.3 | 41.4 | 13.8 | 18.24[c] | 75.57[c] | 61.28[c] | 2.836 |
| Mood liability | 16.1 | 72.5 | 35.9 | 15.5 | 10.61[b] | 105.3[c] | 56.70[c] | 0.0001 |
| Irritability | 11.6 | 65.8 | 30.6 | 11.1 | 10.46[b] | 105.3[c] | 52.19[c] | 0.007 |
| Abdominal pain | 13.9 | 65.8 | 32.1 | 6.9 | 17.52[c] | 94.21[c] | 61.04[c] | 1.852 |
| Skin rash | 17.4 | 62.5 | 33.2 | 19.4 | 4.680[a] | 69.22[c] | 31.84[c] | 0.040 |
| Muscle cramps | 13.0 | 58.3 | 28.9 | 8.3 | 12.21[c] | 75.88[c] | 44.97[c] | 0.733 |
| Arthalgia | 17.4 | 57.5 | 31.5 | 9.7 | 13.01[c] | 56.06[c] | 40.98[c] | 1.939 |
| Cough | 15.2 | 57.5 | 30.0 | 18.0 | 3.663 | 64.30[c] | 27.02[c] | 0.145 |
| Pruritis | 10.3 | 50.8 | 24.5 | 12.5 | 4.254[a] | 64.30[c] | 26.91[c] | 0.090 |
| Nervousness | 11.6 | 50.8 | 25.4 | 9.7 | 7.442[b] | 61.19[c] | 31.48[c] | 0.057 |
| Anorexia | 8.0 | 48.3 | 22.2 | 0 | 18.08[c] | 71.01[c] | 47.60[c] | 4.861[a] |
| Xerodermia | 12.1 | 46.6 | 24.2 | 11.1 | 5.214[a] | 48.93[c] | 24.03[c] | 0.0003 |
| Vertigo | 8.0 | 45.8 | 21.3 | 5.5 | 8.727[b] | 64.17[c] | 32.43[c] | 0.201 |
| Easy bruising | 9.8 | 44.1 | 21.9 | 5.5 | 9.241[b] | 51.74[c] | 30.32[c] | 0.779 |
| Weakness | 3.1 | 43.3 | 17.2 | 2.7 | 8.757[b] | 85.70[c] | 34.63[c] | 0.057 |
| Insomnia | 8.9 | 41.6 | 20.4 | 4.1 | 9.737[b] | 49.36[c] | 29.82[c] | 1.142 |
| Dental caries | 30.9 | 41.6 | 34.7 | 56.9 | 11.52[c] | 3.502 | 3.622 | 14.65[c] |
| Diarrhea | 9.4 | 41.6 | 20.7 | 0 | 16.55[c] | 47.49[c] | 38.43[c] | 5.945[a] |
| Visual problem | 20.6 | 40.0 | 27.4 | 29.1 | 0.025 | 13.76[c] | 1.848 | 1.801 |
| Vomiting | 5.3 | 37.5 | 16.6 | 0 | 12.50[c] | 55.79[c] | 33.21[c] | 2.778 |
| Skin sores | 9.4 | 36.6 | 19.0 | 4.1 | 8.445[b] | 35.96[c] | 23.98[c] | 1.366 |
| Clumsiness | 1.7 | 35.8 | 13.7 | 4.1 | 4.247[a] | 73.60[c] | 23.06[c] | 0.497 |
| Numbness | 1.3 | 33.3 | 12.5 | 1.3 | 6.670[b] | 69.92[c] | 25.47[c] | 0.312 |
| Constipation | 6.2 | 33.3 | 15.7 | 4.1 | 5.790[a] | 41.04[c] | 20.38[c] | 0.143 |
| Dyspnea | 8.0 | 32.5 | 16.6 | 8.3 | 2.561 | 31.86[c] | 13.33[c] | 0.031 |
| Eye discharge | 5.8 | 31.6 | 14.9 | 1.3 | 8.674[b] | 39.13[c] | 23.65[c] | 1.494 |
| Conjunctivitis | 7.6 | 30.8 | 15.7 | 6.9 | 3.091 | 29.96[c] | 13.66[c] | 0.004 |
| Otitis media | 17.4 | 30.8 | 22.2 | 19.4 | 0.123 | 7.300[b] | 2.437 | 0.040 |
| Urinary frequency | 4.4 | 30.8 | 13.7 | 5.5 | 2.948 | 43.60[c] | 15.65[c] | 0.003 |
| Slow weight gain | 3.1 | 30.8 | 12.8 | 0 | 9.023[b] | 51.06[c] | 25.55[c] | 1.158 |
| Misbehavior-home | 5.3 | 30.8 | 14.3 | 6.9 | 2.222 | 39.22[c] | 13.66[c] | 0.042 |
| Diaphoresis | 4.9 | 29.1 | 13.4 | 1.3 | 7.409[b] | 37.40[c] | 21.01[c] | 0.961 |
| Swollen joints | 4.0 | 27.5 | 12.2 | 2.7 | 4.673[a] | 37.82[c] | 16.83[c] | 0.018 |
| Slow healing | 2.6 | 26.6 | 11.1 | 0 | 7.499[b] | 43.12[c] | 21.16[c] | 0.858 |
| Alopecia | 2.2 | 24.1 | 9.9 | 0 | 6.512[a] | 39.58[c] | 18.65[c] | 0.572 |
| Poor grades | 7.6 | 23.3 | 13.1 | 8.3 | 0.860 | 15.54[c] | 5.957[a] | 0.003 |
| Heartburn | 3.5 | 22.5 | 10.2 | 0 | 6.757[b] | 28.43[c] | 17.04[c] | 1.469 |
| Mucus in stool | 1.3 | 22.5 | 8.7 | 0 | 5.547[a] | 41.13[c] | 17.04[c] | 0.098 |
| Bleeding excess | 1.7 | 22.5 | 9.0 | 0 | 5.786[a] | 38.21[c] | 17.04[c] | 0.312 |
| Learning problems | 7.6 | 22.5 | 12.8 | 6.9 | 1.454 | 14.14[c] | 6.760[b] | 0.004 |
| Allergic disorders | 13.0 | 21.6 | 16.0 | 19.4 | 0.283 | 3.728 | 0.034 | 1.333 |
| Abnormal nails | 3.1 | 21.6 | 9.6 | 0 | 6.269[a] | 28.71[c] | 16.24[c] | 1.158 |
| Bedwetting | 9.4 | 20.8 | 13.4 | 12.5 | 0.0003 | 7.801[b] | 1.611 | 0.279 |
| Trouble with peers | 2.2 | 20.0 | 8.5 | 2.7 | 2.014 | 29.53[c] | 9.977[b] | 0.034 |
| Bronchitis | 5.3 | 19.1 | 10.2 | 8.3 | 0.071 | 14.71[c] | 3.317 | 0.393 |
| Dysphagia | 1.7 | 19.1 | 7.9 | 1.3 | 3.011 | 30.12[c] | 11.43[c] | 0.086 |
| Misbehavior-school | 2.2 | 19.1 | 8.2 | 5.5 | 0.261 | 27.59[c] | 5.818[a] | 1.055 |
| Tremors | 0.8 | 18.3 | 7.0 | 1.3 | 2.390 | 33.82[c] | 10.70[b] | 0.098 |
| Dysuria | 3.5 | 18.3 | 8.7 | 2.7 | 2.199 | 19.45[c] | 8.584[b] | 0.002 |
| Acne | 10.7 | 18.3 | 13.4 | 6.9 | 1.748 | 3.227 | 3.933[a] | 0.516 |
| Hair change | 1.3 | 18.3 | 7.3 | 1.3 | 2.594 | 30.85[c] | 10.70[b] | 0.312 |
| Pigment change | 1.3 | 16.6 | 6.7 | 2.7 | 1.002 | 26.88[c] | 7.242[b] | 0.086 |

**Table 1 (Continued)**

| Symptom | Prevalence of symptoms, % | | | | $\chi^2$ (2 × 2) | | | |
|---|---|---|---|---|---|---|---|---|
| | Nonsymptomatic (MN) (223) | Symptomatic (MS) (120) | Total (M) (443) | Total (W) (72) | M vs. W | MS vs. MN | MS vs. W | MN vs. W |
| Sun sensitivity | 3.5 | 15.0 | 7.6 | 4.1 | 0.606 | 12.92[c] | 4.367[a] | 0.018 |
| Fractures | 8.9 | 13.3 | 10.5 | 2.7 | 3.384 | 1.152 | 4.724[a] | 2.192 |
| Slow height gain | 3.5 | 13.3 | 7.0 | 0 | 4.140 | 9.939[b] | 8.800[b] | 1.469 |
| Blood in stool | 0.8 | 12.5 | 5.0 | 0 | 2.566 | 19.90[c] | 8.104[b] | 0.0004 |
| Hematuria | 0 | 12.5 | 4.4 | 1.3 | 0.738 | 26.24[c] | 5.891[a] | 0.356 |
| Pneumonitis | 1.7 | 11.6 | 5.2 | 2.7 | 0.345 | 13.37[c] | 3.564 | 0.001 |
| Urinary infection | 3.1 | 10.0 | 5.5 | 1.3 | 1.422 | 5.769[a] | 4.010[a] | 0.143 |
| Boils | 4.0 | 10.0 | 6.1 | 1.3 | 1.797 | 3.846[a] | 4.010[a] | 0.496 |
| Convulsions | 0.4 | 6.6 | 2.6 | 0 | 0.892 | 9.498[b] | 3.478 | 0.356 |
| Tachycardia | 1.3 | 4.1 | 2.3 | 0 | 0.701 | 1.628 | 1.657 | 0.098 |

[a] Significant, $p < 0.05$.
[b] Significant, $p < 0.01$.
[c] Significant, $p < 0.001$.

**Table 2. Number of Michigan children and percentage with multiple symptoms (MS) by type of farm residence and method of invitation into the study.**

| Quarantined | | | Nonquarantined | | |
|---|---|---|---|---|---|
| Status[a] | Number of Children | MS, % | Status[a] | Number of Children | MS, % |
| Q-R | 50 | 16 | NQ-R | 45 | 18 |
| Q-S | 67 | 51 | NQ-S | 51 | 65 |
| Q-F | 14 | 14 | NQF | 22 | 46 |
| Q-H | 27 | 7 | | | |
| Total | 158 | 29 | Total | 118 | 43 |

[a] Farm status: (Q) quarantined farm; (NQ) nonquarantined farm. Invitation status: (R) selected from random farm list; (S) special, referred, walk-in; (F) Farmer's Advisory Council; (H) selected from highest contamination list.

than were those from nonquarantined farms (34%) ($\chi^2 = 5.29, p < 0.05$). The children from the "highest contaminated" farms were the least likely to have multiple symptoms (7%), while those who entered the study by referral were the most likely to have multiple symptoms (57%).

## Speculation

Children from quarantined farms do not have a higher prevalence of multiple symptoms than those from nonquarantined farms. The following hypothesis to explain this phenomenon will be tested by analysis of PBB levels and dietary histories. The fact that the farm was quarantined may have served as a sufficient warning to decrease the consumption of contaminated food. A nonquarantined status could have been interpreted as assurance that the meat and milk was fit for consumption; and thus, these people continued to eat PBB-containing food. Even though the PBB levels were perhaps below the action level, continued consumption could have resulted in appreciable body burdens of PBB and symptoms of ill health. It may be that symptoms of ill health can be indistinguishably produced by acute, high-level ingestion and by chronic, low-level ingestion of PBBs.